NAIC-ID(RS)T-0204-95

NATIONAL AIR INTELLIGENCE CENTER

HDO3 COMPOSITE MATERIALS APPLICATIONS AND DEVELOPMENT

by

Zhang Ming Jian

**Approved for public release:
distribution unlimited.**

HUMAN TRANSLATION

NAIC-ID (RS)T-0204-95 18 August 1995

MICROFICHE NR: 95C000486L

HD03 COMPOSITE MATERIALS APPLICATIONS AND DEVELOPMENT

By: Zhang Ming Jian

English pages: 9

Source: AVIATION PRODUCTION ENGINEERING
Issue 12, 1993

Country of origin: China

This document is a human translation.
Translated by: Leo Kanner Associates Redwood City, California
F33657-88-D-2188

Quality controlled by: Kristine Mastrog

Requester: NAIC/TATV R. M. Dunco
Approved for public release: distribution unlimited

PREPARED BY:

TRANSLATIONS SERVICES
NATIONAL AIR INTELLIGENCE CENTER
WPAFB, OHIO

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

HDO3 COMPOSITE MATERIALS: APPLICATIONS AND DEVELOPMENT

Zhang Ming Jian

ABSTRACT

This paper introduces HD03 matrix ,properties and the application of its compsites, and exploration of the matrixes on cure at lower temperature.

Key words: HD03 Matrix Composite Property

The HD03 matrix is a composite-resin matrix solidified at 170°C, researched and developed in the early 1980s. Due to its excellent processing and outstanding properties, it became the matrix used for the carbon-fiber-reinforced plastic (CFRP), acrylic-fiber-reinforced plastic (AFRP) and graphite-fiber-reinforced plastic (GFRP) used in many types of aircraft. We have already produced 24 types of components, and from installation and test flights in 1985 to now, have more than seven years' flight experience with these materials.

The development and application of composites for civilian

aircraft brought about new requirements for composites. So we have begun research on reducing HD03 matrix solidification temperatures. Results of the research indicate that we can reduce solidification temperatures while maintaining processing and material properties.

I. HD03 Matrix and Composite Properties

1. Cast Parts Properties (see Table 1)

TABLE 1. Properties of HD03 Matrix Cast Parts

Item	Average Value
Elongation Strength, MPa	65
Elongation Modulus, MPa	2870
Bending Strength, MPa	115
Compression Strength, MPa	202
Compression Modulus, MPa	2900
Elongation Breaking Strength, %	2.9
Poisson Ratio	0.37
Tg*, degrees C	218

*DMA method, tested with Dupont 1090 analyzer

2. Carbon Fiber/HD03 Composite Mechanical Properties

(1) Standard Mechanical Properties

Table 2 shows the average test results for HD03/T300 (3K) pre-wetted materials at -18°C and stored for a period of 9months. In Table 2, one can see that 90^0 directional elongation strength is quite high, showing that both the internal polymerization and fiber bond strength of HD03 are quite high.

(2) Heat and Moisture Resistance

TABLE 2. HD03/T300 Pre-wetting Mechanical Properties

Property	Number of Pieces Tested	Average Value MPa	Coefficient of Variance,%
0° Interface Shear Strength	120	104	4.8
0° Bending Strength	71	1865	7.8
0° Bending Modulus, x 10^3	71	153	6.9
0° Elongation Strength	53	1855	8.4
0° Elongation Modulus, x 10^3	58	146	4.7
90° Elongation Strength	51	67	8.9
90° Elongation Modulus, x 10^3	51	9.5	3.0
90° Compression Strength	16	218	13.5
90° Compression Modulus, x 10^3	18	9.2	12.4
Axial Shear Strength	54	81	5.7
Axial Shear Modulus, x 10^3	54	5.5	3.7

Changes in HD03/T300 (3K) properties after moisture and heat aging at 55°C and relative humidity of 98% are shown in Table 3.

(3) Heat Resistance

Composite interface shear strength changes with respect to temperature for HD03/T300 (3K) are shown in Table 4, which indicates that this type of material possesses high heat resistance, while the interface shear strength still has a retention rate of 56.7% at 150°C.

TABLE 3. Aging Resistance of HD03/T300

Aging Time	Interface Shear Strength		Bending Strength	
	Test Value, MPa	Retention Rate,%	Typical Value MPa	Retention Rate,%
4659h, Ambient Temp.	90	91.1	2098	85.4
11255h, 100°C	44	45.2	1160	48.8

TABLE 4. Temperature Resistance of HD03/T300

Test Temp.	Interface Shear Strength		Bending Strength	
Typical Value, °C	Typical Value, MPa	Retention Rate, %	Typical Value, MPa	Retention Rate, %
Ambient Temp.	104(19°C)	100	1960(25°C)	100
71	81	77.9	172.0	87.7
100	74	71.2	1510	77.0
120	67	64.4	1340(125°C)	68.4
150	59	56.7		

TABLE 5. Effect of Secondary Solidification Temperature on HD03/%300

(1) 固化条件	(2) 测试温度 ℃	(3) 水煮煎		(4) 水煮 24 小时	
		层间剪切强度 (5) MPa	弯曲强度 (6) MPa	层间剪切强度 (5) MPa	弯曲强度 (6) MPa
150℃ / 2h + 150℃ / 2h	28	97	1650	82	1801
	100	66	1498	55	1369
	125	58	1266	43	760
150℃ / 2h + 170℃ / 2h	28	92	1625	85	1799
	100	67	1419	57	1342
	125	64	1313	48	1044

KEY: 1. Solidification conditions; 2. Test temperature,°C; 3. In boiling water; 4. In boiling water for 24 hours; 5. Interface shear strength, MPa; 6. Bending strength, MPa;

3. HD03 Matrix and Composites Applications

CFRP, AFRP, and GFRP using HD03 as a matrix have all been applied in aircraft, and have been used on five types of domestically produced aircraft; the H6, H7, Y7, Y7II and K8. Figs. 1 and 2 are two application examples. Practice has shown that composites have a very broad adaptability. For example, different types of materials can act as the matrix not based on carbon fiber composites, but also for acrylic fiber composites. In terms of composite structures, they can not onlv be used in

laminates, but can also be used as a sandwich layer. Forming can be done by secondary fusing, joint solidification. Unitary solidification, or multiple joint solidification; and all these processing methods are quite stable.

In conducting comparison experiments with domestically produced HD03/acrylic composites and imported 914/Kevlar49, 934/Kevlar49, 934/Kevlar149, 828-BDMA/Kevlar49, 828-BDMA/Kevlar49, we found that the properties of the composite formed by HD03 matrix with domestically produced acrylic were all superior to those of the composite formed with imported materials and Kevlar fiber. Upon analysis, we find that the mechanical properties of domestically produced acrylics are inferior to Kevlar49 and Kevlar149. So it is clear that the properties of the HD03 matrix are superior to those of 914, 934, 828-BDMA, etc. matrixes.

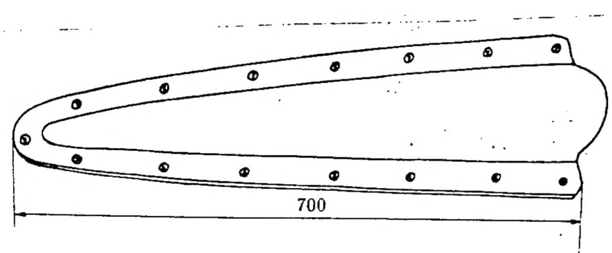

Fig. 1. H6 aircraft aileron adjuster
Operational-arm fairing schematic

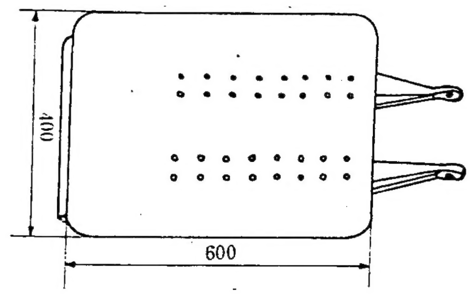

Fig. 2. H7 aircraft lower resistance panel schematic

II. HD03 Matrix Improvements and Composite Properties

Improvements primarily address the needs of civilian aircraft and the implementation of reduction in solidification temperature.

1. Experiments on solidification at 150°C

The experimental data are follows: solidification at 150°C, and secondary solidification at 150 and 170°C.

Experimental results indicate that, for HD03 materials solidified at 170°C, the secondary solidification temperature has an effect on the matrix composite properties at 125°, but does not affect properties under 100°C. So, for civilian aircraft used at under 100°C, use of materials solidification processed at 150°C satisfy all requirements. For specific results of the

experiments, see Table 5.

2. Experiments on solidification at 130°C

The experimental data are as follows: solidification at 130°C, and secondary solidification at 150°C.

After solidification at 130°C, for HD03 cast parts tested in the experimental temperature range (25-100°C) the temperature has little effect on elongation strength and elongation rate, but the values are higher than HD03 (see Table 1). HD03/T300 composite material mechanical properties at normal temperatures are as follows: bending strength is 1750MPa; elongation strength at 0^0 is 1600MPa; and compression strength is 1206MPa; using the Dupont 1090 Dynamic Mechanical Analyzer (DMA) test results show a vitrification point of 187°C.

III. Conclusions

After numerous experiments, we can draw the following conclusions:

1. HD03 matrix has a relatively high temperature resistance. Below 125°C, it has a relatively high retention rate, and it can be used at under 120°C.

2. HD03 matrix possesses processing properties which make it

suitable for mass production.

3. Using the HD03 series solidified at 130/150°C, we can reach a 90% solidification rate. Cast parts elongation strength and the composite's 90^0 elongation strength are both greater than HD03. Interface shear strength and bending strength are both below the values for primary HD03, but still have a relatively high rate of retention under 100°C, so it can be used for civilian aircraft.

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE
B085 DIA/RTS-2FI	1
C509 BALLOC509 BALLISTIC RES LAB	1
C510 R&T LABS/AVEADCOM	1
C513 ARRADCOM	1
C535 AVRADCOM/TSARCOM	1
C539 TRASANA	1
Q592 FSTC	4
Q619 MSIC REDSTONE	1
Q008 NTIC	1
Q043 AFMIC-IS	1
E404 AEDC/DOF	1
E410 AFDTC/IN	1
E429 SD/IND	1
P005 DOE/ISA/DDI	1
1051 AFIT/LDE	1
P090 NSA/CDB	1

Microfiche Nbr: FTD95C000486L
NAIC-ID(RS)T-0204-95